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ABSTRACT

The "Talking Typewriter" is a computerized electric typewriter with visual and audio capabilities. It was designed to create an environment where learning to read would be a successful, enjoyable experience for the student by allowing him to explore, discover relationships, to progress at his own speed, and to receive feedback. This report describes the "Talking Typewriter" and discusses its characteristics; the rationale behind its development; the hardware, software, lessons, and other materials to be used with it; and procedures for its use. Key personnel, sources and evolutions of ideas, and funding for the project are briefly discussed in a section on origins, and the procedures used in developing the hardware and software of the "Talking Typewriter" are described. Information about formative and summative evaluations is provided, and the extent of diffusion and adoption of this innovation are also described. Speculations about the future of the product are offered, and a list of the crucial decisions made during the development of the product concludes the report. (SH)

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PRODUCT DEVELOPMENT REPORT NO. 12

THE EDISON RESPONSIVE ENVIRONMENT LEARNING SYSTEM, OR THE TALKING TYPEWRITER

DEVELOPED BY THOMAS A. EDISON LABORATORY,
A SUBSIDIARY OF McGRAW EDISON COMPANY

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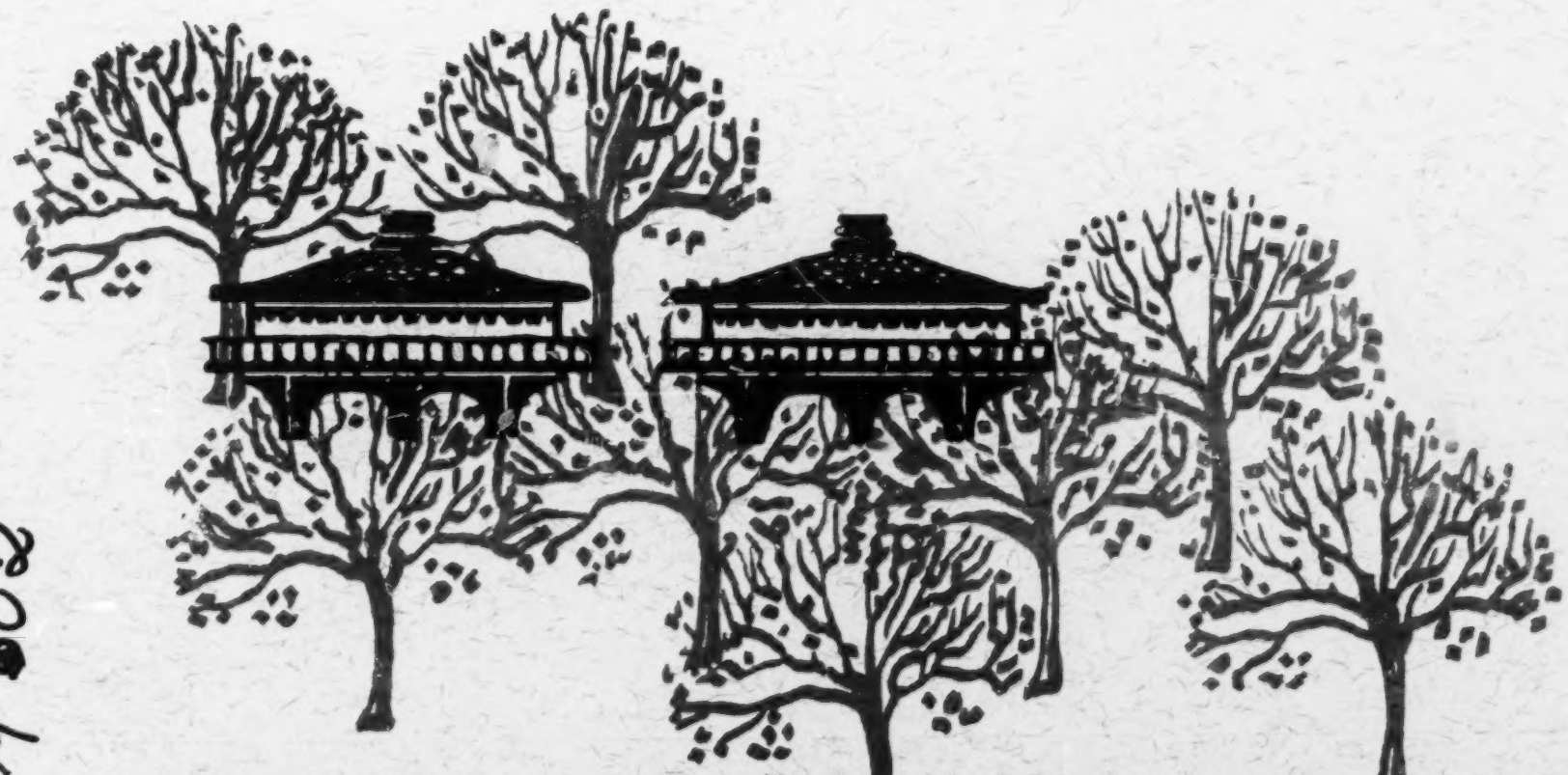

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American Institutes for Research
in the Behavioral Sciences

Palo Alto, California

January, 1972

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Office of Education
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PREFACE

This product development report is one of 21 such reports, each dealing with the developmental history of a recent educational product. A list of the 21 products, and the agencies responsible for their development, is contained in Appendix A to this report. The study, of which this report is a component, was supported by U.S. Office of Education Contract No. OEC-0-70-4892, entitled "The Evaluation of the Impact of Educational Research and Development Products." The overall project was designed to examine the process of development of "successful educational products."

This report represents a relatively unique attempt to document what occurred in the development of a recent educational product that appears to have potential impact. The report is based upon published materials, documents in the files of the developing agency, and interviews with staff who were involved in the development of the product. A draft of each study was reviewed by the developer's staff. Generally, their suggestions for revisions were incorporated into the text; however, complete responsibility for interpretations concerning any facet of development, evaluation, and diffusion rests with the authors of this report.

Although awareness of the full impact of the study requires reading both the individual product development reports and the separate final report, each study may be read individually. For a quick overview of essential events in the product history, the reader is referred to those sections of the report containing the flow chart and the critical decision record.

The final report contains: a complete discussion of the procedures and the selection criteria used to identify exemplary educational products; generalizations drawn from the 21 product development case studies; a comparison of these generalizations with hypotheses currently existing in the literature regarding the processes of innovation and change; and the identification of some proposed data sources through which the U.S. Office of Education could monitor the impact of developing products. The final report also includes a detailed outline of the search procedures and the information sought for each case report.

Permanent project staff consisted of Calvin E. Wright, Principal Investigator; Jack J. Crawford, Project Director; Daniel W. Kratochvil, Research Scientist; and Carolyn A. Morrow, Administrative Assistant. In addition, other staff who assisted in the preparation of individual product reports are identified on the appropriate title pages. The Project Monitor was Dr. Alice Y. Scates of the USOE Office of Program Planning and Evaluation.

Sincere gratitude is extended to those overburdened staff members of the 21 product development studies who courteously and freely gave their time so that we might present a detailed and relatively accurate picture of the events in the development of some exemplary educational research and development products. If we have chronicled a just and moderately complete account of the birth of these products and the hard work that spawned them, credit lies with those staff members of each product development team who ransacked memory and files to recreate history.

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PRODUCT DESCRIPTION

Product Characteristics

Name

The Edison Responsive Environment Learning System, or the Talking Typewriter. The name Talking Typewriter will be generally used in this report.

Developer

The Talking Typewriter was conceived by Omar Khayyam Moore and designed by Richard Kobler at the Thomas A. Edison Laboratory, a subsidiary of McGraw Edison Company.

Distributor

The Responsive Environments Corporation (REC) distributes the Talking Typewriter.

Focus

The Talking Typewriter is a computerized electric typewriter with visual and audio capabilities. One of the several reading programs available from REC for use with the Talking Typewriter is based on the Behavioral Research Laboratories (BRL) Sullivan Reading Program and provides instruction in basic reading skills.

Grade Level

The Talking Typewriter can be used with students of all ages. However, most software used with the typewriter is written for kindergarten through grade three reading levels.

Target Population

The Talking Typewriter is appropriate for any student who lacks basic reading skills, including preschool children, beginning readers, disadvantaged children, students who require remedial reading instruction, retarded and handicapped children, and illiterate or non-English-speaking adults.

Rationale for Product

Long Range Goals of Product

The purpose for using the Talking Typewriter is to create an environment where learning will be a successful, enjoyable experience for the student.

The machine and accompanying programs are designed to allow the student to explore, to discover relationships, to progress at his own speed, to receive feedback on the correctness of his response, and to experience success. The development of the typewriter has led to two similar products, the Talking Page and the Voice Mirror, which are based on the same approach and have similar objectives.

Objectives of Product

The Talking Typewriter is an instructional machine which can be programmed to meet different objectives. It was used primarily as a research tool at first, but, since 1964, it has been used in schools and institutions to teach reading skills. REC has developed the "REC Systems Design for Basic Reading Skills"; this includes the Talking Typewriter, programs for the typewriter based on the BRL Sullivan Reading Program, locally developed programs, BRL Sullivan workbooks, correlated supplementary reading, and related classroom activities. The objectives of this system are to teach basic reading to students who lack decoding skills. Users have also reported some significant non-cognitive outcomes of the program, including positive changes in student self-image, motivation, and attitudes.

Philosophy and Theories Supporting Product

Omar Khayyam Moore contributed the basic theory and methodology of the Talking Typewriter and first used the term "responsive environment." However, the Talking Typewriter system marketed by REC departs in some respects from the Moorian philosophy and reflects somewhat of a Skinnerian influence.

Moore, a sociologist-psychologist whose major interest is in the area of symbolic logic, began using an electric typewriter in the late 1950's as a research tool in the development of a theory of problem solving and social interaction. He began to use young children in his studies and demonstrated how very young children, including his own two-and-a-half year old daughter, could learn to read quickly and easily using an electric typewriter. Moore explained this phenomenon with the notion that the typewriter provides an "autotelic responsive environment" in which the acquisition of complex skills can be accelerated. He specified the following characteristics (Moore, 1966) of a responsive environment:

1. It permits the learner to explore freely.

2. It informs the learner immediately about the consequences of his actions.

3. It is self-pacing; i.e., events happen within the environment at a rate determined by the learner.

4. It permits the learner to make full use of his capacity for discovering relations of various kinds.

5. Its structure is such that the learner is likely to make a series of interconnected discoveries about the physical, cultural, or social world.

Moore defined an autotelic environment as one in which activities are engaged in for their own sake rather than for obtaining rewards or punishments that have no inherent connection with the activity itself. He felt that extrinsic rewards and punishments make the learning situation unnecessarily complex and that children derive pleasure from discovering relationships if provided a suitable environment (Moore, 1966). Moore attributed some of these ideas to the work of sociologists George Simmel and George Herbert Meade.

Moore began to design an environment for young children which would be both responsive and autotelic; he went on to evolve a laboratory system using an electric typewriter and a booth attendant. The Edison Responsive Environment is an automated version of the system created by Moore.

As used by REC, the Edison Responsive Environment, or Talking Typewriter, still creates an environment which is responsive to the student, but does differ from Moore's system in some ways. Moore placed more emphasis on the exploratory phases of his system and wrote special programs for each individual student. He viewed the typewriter as a means by which children could learn to learn, to discover relationships, and solve problems, and not just as a means of teaching reading. REC places more stress on the typewriter as a tool for teaching beginning reading skills and allows the student less time for free exploration and discovery. The REC system provides the student with more structure to encourage the student to perceive specific relationships. REC found that schools did not have the resources to develop an individual program for each student, and supplies a set of programs which teach basic reading through systematic development of

skills using a linguistic approach. Students learn through a combination of pre-prepared programs matched to the student's needs, locally prepared programs to develop interest or motivation or to meet special needs, and related classroom activities.

The system reflects, in some respects, a Skinnerian stimulus-response type of approach. The typewriter can limit the student's response and the programs are based on programmed learning techniques used by Skinner in which a complex task is broken down into simpler behaviors. The Talking Typewriter adds new dimensions to the programmed textbook approach because the student's response can be controlled and because of the audio component.

Moore continues to conduct his own research at the Learning Research and Development Center at the University of Pittsburgh and is extending his theoretical work to include the concept of the clarifying environments (Moore, 1971).

Description of Materials

Organization and Format of Materials

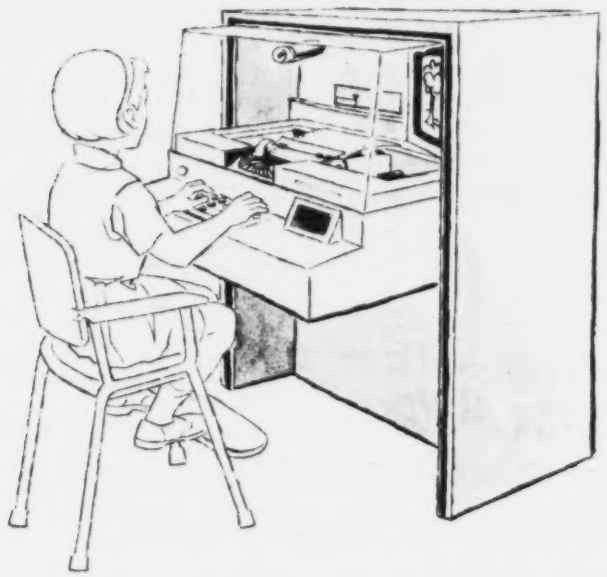
The Talking Typewriter is used as part of the REC System Design for Basic Reading Skills which includes: 128 programmed lessons for the typewriter based on the BRL Sullivan Reading Program; locally developed programs designed to meet needs of individual students; BRL Sullivan workbooks which are used for related classroom activities; supplementary reading including BRL Sullivan readers; and testing materials and teacher's manuals.

The heart of the system is the Talking Typewriter (see Figure 1 below). The Talking Typewriter consists of: an electric typewriter; an exhibitor where letters, words, and sentences can be shown; a pointer; a slide projector and screen; and a microphone and speaker. The keyboard and audio and visual components are controlled by a small computer and the machine is packaged in one unit. The machine is used by one child at a time, and the child interacts with the machine by striking keys on the keyboard.

The Talking Typewriter is designed to be a flexible machine which can be used in different ways. In the first phase of the machine, the exploratory phase, the Talking Typewriter acts just as an electric typewriter and types the letters as the keys are pressed by the student. In the next phase of the machine, the keyvoice phase, a voice pronounces each letter after the

student types it. In the next phase the machine is controlled by a magnetic program card which is inserted into the machine. The program controls the audio and visual components of the machine and controls which keys can be depressed on the keyboard. The machine can be adjusted in various ways to affect such variables as the number of hints or clues given to the student while he is working on a program, when these hints occur, and the time between them.

Figure 1. The Talking Typewriter



(New York City, 1968)

The typewriter is generally located at a center which has one or more typewriters. The center must be air-conditioned for proper operation of the machine. The typewriter itself is housed in a booth about six feet by five feet in size with a one-way mirror so the student will not be distracted, but so a booth attendant can see if the student is having any problems.

Content of the Materials

The software for the Talking Typewriter is based on the BRL Sullivan Reading Program. This program uses a linguistic approach which teaches letter and sound correspondence, or code cracking skills, through presentation of carefully selected letters and words. The illustrations in the programs are the same as in the BRL Sullivan series and are appropriate for use with students of all ages. BRL Sullivan programmed workbooks, storybooks, and tests are also used in the system in related classroom activities.

Several programs have been written, but have not been produced in encoded card form. These programs are available in program chart form for encoding by the user, and all necessary slides are available. REC has been able to make these programs available to a number of projects in this form. These programs include the Basic Vocabulary and Comprehension Program, a group of 34 programs which teach a basic sight vocabulary of the most frequently used words. Another program is the Springboards Series, designed to teach vocabulary included in the individual Springboards stories now published by Noble and Noble. The intent in developing these programs was to provide materials dealing with sight words and comprehension skills, as compared with the exclusively phonic approach in the REC-BRL Sullivan programs for the Talking Typewriter. The El Cajon Phonics Program, developed by the El Cajon Reading Clinic in El Cajon, California, will be available soon. These programs were designed using REC program generator models and will be marketed by the reading clinic itself.

Cost of Materials to User

The Talking Typewriter can be purchased for about $37,500 and is also available on a lease plan. A five year lease is $800 monthly. Additional expenses include: a separate maintenance contract with the Thomas A. Edison Laboratory; the programs to be used with the typewriter which are available from REC; and the BRL Sullivan workbooks and other materials which are purchased from BRL. Projects must also consider the cost of physical facilities needed for a center and of staff to maintain the center. The per-pupil costs vary depending on how the typewriter is used. They are generally highest when used in institutions with mentally or physically handicapped students who often require extensive instruction to master the basic reading skills. Some centers have substantially reduced the per-pupil costs by using the machines after school, evenings, and summers with various populations and by carefully screening students to select those who can benefit most from the typewriter.

Procedures for Using Product

Learner Activities

Students typically spend one hour a day at a learning center. Fifteen to twenty minutes of this time is spent with the Talking Typewriter, although

adults and teenagers may spend longer since they have longer attention spans. The remainder of the time is spent in related classroom activities which reinforce what has been learned on the typewriter. The student is introduced to the typewriter through a free exploration phase. If he strikes a key, the machine will type the letter; later a voice will say the letter after it is typed. When the student seems familiar with the typewriter, programs are introduced and the machine gives directions to the students. For example, a voice may say, "Type the letter A," while the letter "A" is projected on a screen. Since all the keys on the keyboard are blocked, the only response the student can make is the correct one, the letter "A." The voice will repeat the directions and give additional clues until the student strikes the "A" key. In later lessons the student performs more complex behaviors involving words and sentences, and pictures are shown to represent words. The keyboard and the audio and visual capabilities of the machine can be combined in various ways to meet the objectives of each lesson. Sometimes students go back to the free type phase for periods of time to explore the typewriter as they wish.

When the student's time on the Talking Typewriter is over, the booth attendant gives him the typewriter printout, and he goes to the related classroom for activities with teachers and other students to practice what he has learned. Activities include review of the typewriter printout with a teacher, assignments in BRL Sullivan workbooks and readers, practice in areas where he is having learning difficulties, and games and other activities with groups of children.

Both the length of time and the frequency with which a student attends a center depend upon the needs of the student. For some students six to eight weeks of daily instruction at a center is sufficient; other students come to a center for a semester or a year. Centers have experimented with different forms of scheduling, ranging from daily instruction for an entire year, to weekly instruction for a period of a few weeks or months. Both the efficiency and effectiveness of the Talking Typewriter have increased as programs were more carefully selected to cover only those skills needed, as determined by diagnostic tests and progress checks. Thus, rather than using an entire series of programs with a student, only those segments which are necessary are selected and prescribed. This has made individualized assignments possible and decreased the amount of machine time formerly needed.

This procedure is a departure from the one first recommended by REC--that of relying more heavily on the BRL Sullivan Placement Test. Many users found the test too crude for precise placement and substituted diagnostic tests of phonics skills.

Teacher Activities

The staff required for a center depends on the number of typewriters. A large center requires a director to supervise the development and operation of the program. At least one teacher is required for each center to coordinate and conduct classroom activities and to assess student progress. The teacher or other specially trained personnel also develop programs for the typewriter which are designed to meet the specific needs or interests of particular students. The centers also require one booth attendant for every two typewriters to operate the machines, to help students if they have problems while using the typewriter, to encode programs, and to keep records on student progress. Training for all center personnel is provided by REC consultants.

Provisions for Parent/Community Involvement

The amount of community involvement varies among centers. Some projects have an advisory council composed of community members who make recommendations on policies and practices at the center. Most centers select the non-professional staff from the local area to increase community involvement and contact. Often special programs are operated for segments of the community such as dropouts and illiterate adults. All these practices help to create community involvement and support for a center.

Special Physical Facilities or Equipment

An air-conditioned room is required to house the Talking Typewriter. Space is also needed for the related classroom activities.

Recommended Assessment Techniques for Users

A screening test is provided for use in selecting students who could benefit most from the typewriter. A Sullivan placement examination is then administered to determine the appropriate level for the student to begin instruction. Short tests, based on the Sullivan curriculum, are given regularly to provide a record of student progress. REC also strongly recommends that each center administer a standardized reading test as a pre- and posttest to all students who attend the center in order to evaluate the effectiveness of the program.

ORIGINS

Key Personnel

Dr. Omar Khayyam Moore, a sociologist-psychologist, conceived the notion of the Talking Typewriter and contributed the methodology and theory for the product. Moore's main interest is in the area of human problem-solving; in the late 1950's he began to use the typewriter with children as a tool in his studies. This was the beginning of a long term research project supported by the Office of Naval Research, the Carnegie Corporation, and other funding sources. He is currently continuing his research at the Learning Research and Development Center at the University of Pittsburgh.

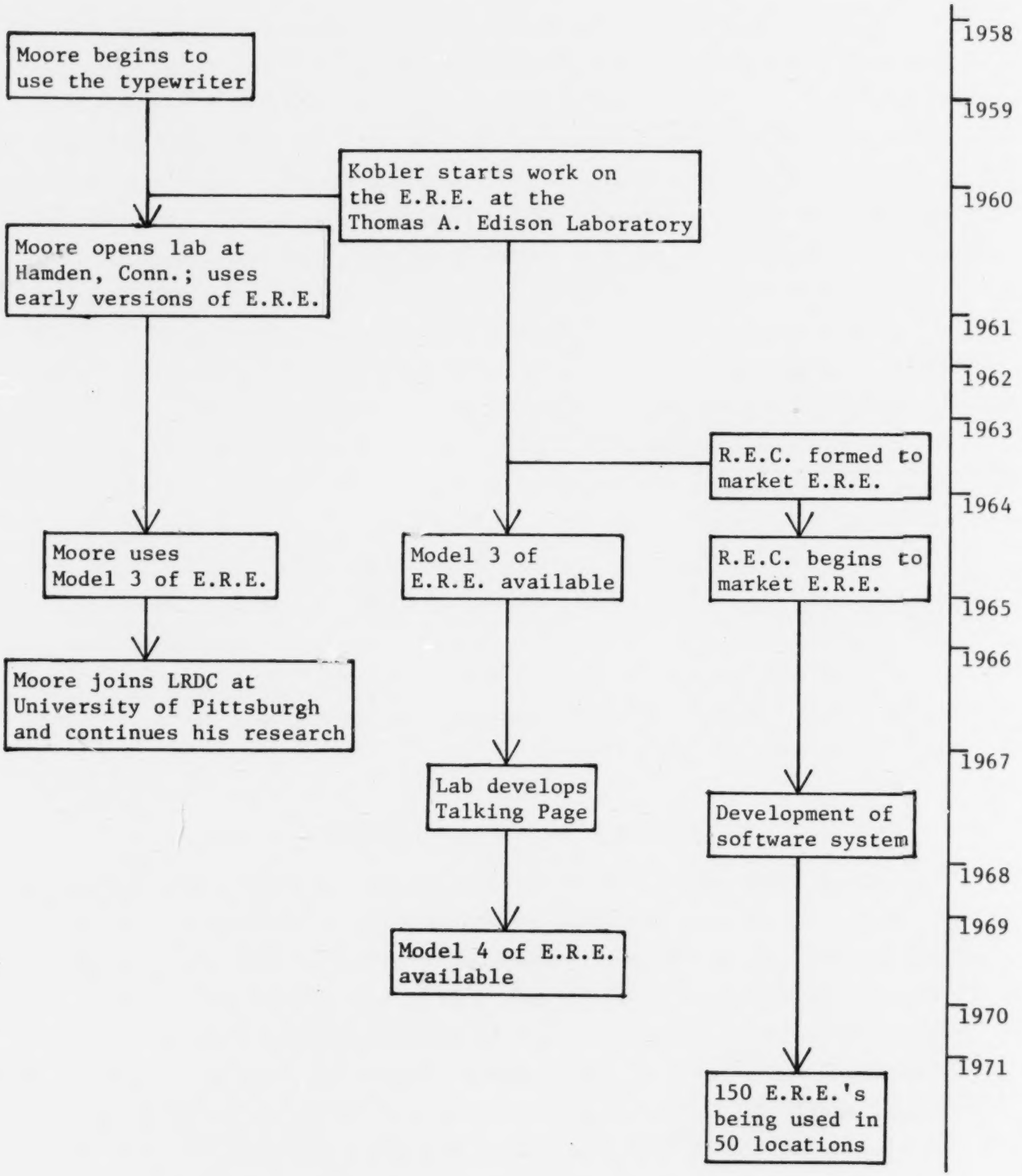
The technology for the Talking Typewriter was contributed by Richard Kobler, an inventor-engineer. The early versions of the typewriter used by Moore required a person to operate the controls. In 1959, Kobler began working with Moore to automate the typewriter and to extend its capabilities. Richard Kobler had been on the staff of the Thomas A. Edison Laboratory, a subsidiary of the McGraw Edison Company, since 1943; he had developed other devices, including a dictating machine, a data processing service which enabled rapid dialing of a telephone, and a simple Skinnerian-type learning machine. He directed the work on the Talking Typewriter and, since then, has taken an increased interest in how the machine can be used. He has also developed two other learning devices now marketed by REC, the Talking Page and the Voice Mirror.

Sources and Evolution of Ideas for Product

Around 1958, while at Yale University, Omar Khayyam Moore began to use an electric typewriter with his two-and-half-year-old daughter. He made a film shortly afterwards which showed three- and four-year-old children, including his daughter, reading and typing words and sentences. This film was startling since schools did not generally introduce reading until the first grade and because it was a popular notion that children could not learn to read until then. (See Figure 2 on the next page for the major events in the history of the Talking Typewriter, beginning with Moore's early work with the typewriter.)

Figure 2

Major Event Flow Chart



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Richard Kobler heard about the film and rented it. Little work had been done in the field of teaching machines at this time, but Kobler was already interested in applying technology to the development of educational equipment and had invented a simple educational device. When he saw the film, he realized he could use existing technology to automate the equipment and made an appointment with Moore to discuss the matter. As a result, Kobler and Moore began to collaborate to automate the typewriter based on Moore's notion of a responsive environment. The engineering work was done at the Thomas A. Edison Laroratory under the direction of Kobler. Moore served as a consultant to the laboratory over a period of several years.

In 1960 Moore established a Responsive Environment Laboratory in Hamden Hall Country Day School, Hamden, Connecticut, where he further defined the elements of an autotelic responsive environment. It was here that a child nicknamed the machine the "Talking Typewriter." Moore's early use of an electric typewriter in a responsive environment required an adult, the booth attendant, to be in the room with the student to operate the typewriter and structure the learning environment. The equipment consisted of an electric typewriter, a projector and screen, and a pointer. The booth attendant sat beside the student where she could clearly see the keyboard, and she held a control switch with which to turn the typewriter on and off. The booth attendant was instructed to be passive and not intrude on the student.

In Phase 1, the child could explore the keyboard freely. As the student typed a letter or symbol, the attendant would say it aloud. Sometimes the student would hit several keys at once and the keyboard would jam; sometimes the student would strike the keys rapidly in succession, and it was difficult for the attendant to keep up with the student or for the student to hear what was said. In Phase 2, a projector showed a letter on a screen while the attendant pointed to the letter. The attendant would turn the machine off when the student approached an incorrect letter, and the only key the student could depress was the key corresponding to the character on the screen. The attendant had to watch carefully to see where the student's fingers were and could not always prevent errors. Sometimes the students had difficulty perceiving what the relationship was and were confused by human errors. Similar mechanical drawbacks existed in Moore's

next two phases--the word construction phase in which students learned to read and write words selected by Moore from classic children's stories and from the child's own vocabulary, and Phase 4 in which students would read and write sentences and paragraphs using the words they had learned.

The method Moore used with the typewriter was structured to meet his requirements for a responsive environment and is described in more detail in his article "Autotelic Responsive Environments and Exceptional Children" (Moore, 1966). Moore did not use his system to just teach reading, but attempted to give equal emphasis to speaking, writing, listening, and reading and their relationship and to develop "higher-order intellectual abilities which may be thought of as ranging over this complex of linguistic processes" (Moore, 1966, p. 179). Moore had students progress through the four phases which he attempted to structure in such a way that the student was likely to make a series of interconnected discoveries. Students were allowed the freedom to choose if they wanted to come to the laboratory; while they were with the typewriter, they were cut off from significant people in their life, such as teachers. Each student was introduced to the booth by another student. Before using the typewriter, his fingernails were painted to correspond to the color of keys on the typewriter to encourage correct fingering. In Moore's method the environment was carefully structured so that the student could learn in a way that was responsive to his behaviors, potentially playful and individualized.

Funding for Product

The Thomas A. Edison Laboratory supported the cost of automating the Talking Typewriter. No cost figures are available, but at least a million dollars were invested before the machine was ready for marketing, and about that much has been spent since then. In 1963 Responsive Environments Corporation (REC) was created to market the Talking Typewriter, and in 1967 REC supported the development of software for the machine. REC's investment has been substantial, and matches the cost to develop the machine. Thus, total development costs were about two to four million dollars.

PRODUCT DEVELOPMENT

Management and Organization

The Thomas A. Edison Laboratory was a small research laboratory for McGraw Edison with about 50 employees. The laboratory began to develop educational devices in the late 1950's when they started to automate the Talking Typewriter; since the middle 1960's, their work has been primarily in the area of educational technology. All the engineering work on the Talking Typewriter was done by the laboratory which continues to service the equipment.

In 1963, REC was created by a few large investors as the marketing organization for the products of the Thomas A. Edison Laboratory, namely the Talking Typewriter. The Laboratory and REC are independent and work together through contractual agreements. As REC marketed the typewriter, they found that software was required; they established their program department in 1967 to provide this software.

Original Development Plan and Modifications

In 1959, the laboratory began to apply technology to automate the typewriter, and improvements and refinements were gradually made over the next ten years. This was an inventive process and did not follow a rigid preplanned schedule but progressed in phases. There were no plans at all for the development of software. The procedures for programming the typewriter are relatively simple, and it was expected that teachers would write programs for individual students as Moore had done. In addition, the developers and marketers were not educators. They had faith in the teaching capabilities of the machine itself and had little concern for the programs which would be used with the machine. However, when they began to use the typewriter in the schools, they found that teachers did not have the time or resources to develop a separate, well-formulated program for each student even though completely individualized programs might be desirable. At that time, REC developed a set of programs designed to teach reading skills. Most centers start students at the appropriate level in the series and use locally developed programs as a supplement.

Actual Procedures for Development of Product

Development of Hardware

Richard Kobler directed the development of the hardware for the Talking Typewriter. Moore served as a consultant on the project, particularly from 1960 to 1963.

The typewriter underwent many modifications before it was developed into the machine that is available today. The first change was to add a device to prevent the jamming of keys. Then, if a student struck more than one key at a time, none of the keys would strike. Next, a device was added to prevent any key from being depressed as the name of the previous symbol was pronounced. This enabled students to discover more easily the relationship between the key they had struck and the name of the corresponding character. A major change was the addition of an acoustical device so the machine, rather than a booth attendant, pronounced the letters, words, and sentences. Another important addition was the device that selectively unblocked a single key on the keyboard. This meant that the attendant no longer had to turn off the machine to prevent the student from making an error. Now the student could only make the correct response. The visual component was improved and included: an exhibitor in front of the student, a machine pointer, and a screen on which slides could be shown.

Other refinements included audio component controls to regulate pacing and other variables and a dictating device to allow a student to record his own voice and compare it to a master voice. Features were also added to "childproof" the machine, such as the lucite cover that protects the typewriter keys. Patents were filed on many of these devices.

The Talking Typewriter underwent several model changes. The first two models were basically prototypes, but schools began using Model 3 in 1964. Many changes were made on Model 3 in the late 1960's, and it became Model 4. Early versions of the typewriter were not very reliable and broke down frequently. The machines were improved through modifications and now breakdowns are rare.

The automated system is more expensive than the non-automated system, and some people have doubted that it is more effective. Moore himself used a combination of automated and non-automated equipment and questioned the psychological effect of using all automated equipment. Kobler believes that

the automated system is superior, both from a practical operating viewpoint and from the viewpoint of human relations. The automated equipment has some clear advantages in terms of keyboard, and visual and audio capabilities. According to Kobler, the non-automated equipment is too complicated for many booth attendants to operate without making frequent errors. But Kobler objects most strongly to the non-automated equipment because of the unnatural situation created between the child and the adult. He contends that putting an adult into the system changes it from a child and a machine to a child, an adult, and a machine. The child soon learns that he can control the behavior of another person--the attendant--through his behavior, and Kobler argues that this is an undesirable situation which dehumanizes the attendant. Kobler is in favor, however, of having people available to the student while he is interacting with the typewriter.

Development of Software

In 1966, after the first attempt to install the Talking Typewriter on a large scale in a school setting, REC decided they must develop software to market with the machine. Dr. Milton S. Katz, a psychologist who had most recently directed the Program Development Division of the Job Corps, was recruited to direct the development of a program to accompany the Talking Typewriter. Katz recommended the development of a library of programs that teachers could supplement with their own programs. He was familiar with the Sullivan approach to teaching reading skills through his work with the Job Corps. He felt that the BRL Sullivan materials would be appropriate for adaptation on the Talking Typewriter because they use a sequential, developmental approach, a programmed instruction format, and illustrations which are appropriate for all age levels. Katz discussed the matter with the managers of BRL and they agreed to the idea with the understanding that BRL materials would be used in the related classroom activities.

In the spring and summer of 1967, 128 programs were developed in a crash effort to produce materials for the schools that fall. The programs were based on the BRL Sullivan materials and even used the same illustrations. The development of the programs was a major undertaking. Tasks included planning the program, writing the program, specifying detailed machine directions, preparing slides, and editing programs to insure that the keyboard, and audio and visual components were coordinated. These programs were later

revised and became part of a system which also includes testing procedures for assigning programs to students and related classroom activities which reinforced what the students learned in the programs.

The advantages of using the BRL Sullivan program with the typewriter rather than just in the programmed instruction book format are: (1) the addition of the audio component which is important in relating speech to reading and writing, and (2) the control the typewriter gives over a student's responses and which prevents the student from making and repeating errors. A disadvantage in using the Sullivan program is that it sometimes confuses students who are being taught to read using another reading approach in their regular classroom; however, this would be true of any reading program selected for use with the Talking Typewriter.

Several types of program generator models were developed to enable local center staffs to write more of their own programs. As noted above under Product Description, other series of programs for the typewriter were written, but only one was produced in finished card form--a driver's training program for teenagers and adults. Dr. Katz estimated that the cost of producing one net 20-minute program (or approximately one hour of instruction, including related activities and student response time) is approximately $10,000 and that the cost of developing adequate software generally requires from 25-30% of the cost of developing the associated hardware.

Approximately three years (from mid-1968 to mid-1971) were required to develop programs which went beyond the original programs based on the BRL Sullivan materials and exploited the full capability of the Talking Typewriter. One project, consisting of 21 Talking Typewriters located in two centers in Minneapolis, Minnesota, played an important role in software development after the REC-BRL Sullivan programs became available. Unlike most centers, this one initially had financial resources available to develop, test, and revise an extensive series of programs, a phase of development which could not be undertaken by REC at that time due to the prohibitive cost. The project began using REC program generator models to develop programs, and also used the REC Basic Vocabulary and Comprehension Program.

Formative Evaluation

In developing the hardware of the Talking Typewriter, the best indicator was the reliability of the equipment--either it worked or it didn't work. Little feedback from users was considered in revising the software. The program development staff felt it would have been desirable to have records on students' responses, particularly incorrect responses, but this information was not obtained. Although the BRL Sullivan materials had gone through formative evaluation, this only slightly reduced the need for formative evaluation of the Sullivan materials used with the Talking Typewriter. Many questions pertaining to the effectiveness of the Sullivan program used with the typewriter and the importance of related activities were never fully explored. Moore's early research activities were the only activities that came close to those typically considered formative evaluation.

In a sense, Moore's research constituted a formative evaluation of the methodology of using a typewriter system. He used the first versions of the automated typewriter and provided feedback which influenced later development of the equipment. Moore has not reported any empirical data from any controlled experimental studies, but has described case studies on individual children which show remarkable student achievement. Moore explains his procedures this way:

> Over the years we have made dozens of studies in the course of constructing new environments and checking them out. These "quick and dirty" experiments are very much like those to be found in ordinary engineering practice. . . . I believe it was A. N. Whitehead who suggested that a controlled experiment should be thought of as something like a cavalry charge--one does not charge often, and one does it only for the sake of capturing a vital point. The heart of daily laboratory operations is to get a "go-or-no-go" answer to a problem. If the answer is positive, then one moves on. (Moore, 1971, p. 76)

Other early research activities with the typewriter should also be discussed for, although they were not evaluations of REC's hardware and software package, they did testify to the potential of the typewriter and are an important part of its history. Dr. Lassar Gotkin, of the Institute for Developmental Studies at New York University School of Education, was an early user of the Talking Typewriter. He began to use it in 1964 as part of a research study on how children learned. Although his research findings were valuable, he did not use the full capacity of the machine or

evaluate it in terms of its effectiveness as a teaching device. Dr. Mary S. Goodwin and Dr. T. Campbell Goodwin, pediatricians, also began to use the typewriter in 1964 and explored its appropriateness with over 150 mentally, physically, and emotionally handicapped youngsters. The Goodwins did not run controlled studies but prepared case studies on children's progress. They found the typewriter to be a useful tool. Many of the children made substantial cognitive or emotional gains, and some showed unexpected improvements.

SUMMATIVE EVALUATION

Each center using the Talking Typewriter has been urged to conduct an evaluation in order to judge the effectiveness of their program, and numerous studies have been made. The results of these studies have varied, but generally they have reported that students make significant reading gains while they are using the Talking Typewriter. However, a major criticism of these studies must be made before a sample of them are discussed. A major problem in all the studies has been that the students were or had been exposed to other reading programs in their regular classrooms, and it was difficult to isolate the effects of the typewriter alone, or even of the REC system alone. Consequently, it was impossible to ascertain what the treatments were; in some cases what the control groups were doing is not clear either.

Results of some evaluation studies done by two of the larger centers will be discussed as examples of the type of evaluations which have been conducted. In 1966, a center with 20 Model III Talking Typewriters opened in Brooklyn, New York, with funding by the Office of Economic Opportunity. The center developed a large library of programs for the typewriter and also used REC prepared programs. A short study was conducted during the first six months of 1967 which showed that experimental kindergarten and first grade groups made more improvement in certain reading skills as measured by standardized tests than control groups. The first full year study was conducted in 1967-68. Results showed that first grade experimental classes performed significantly better on the Metropolitan Achievement Tests than control groups. Eighth and tenth grade experimental remedial readers also showed significant gains as compared to control groups in reading comprehension, but not in word knowledge, as measured by Metropolitan Achievement

Tests. There were no discernible differences found between the two groups of second grade students. A similar evaluation in 1968-69 also showed some significant differences favoring the experimental groups at the grades tested--kindergarten, first, eighth, and ninth grades. The results of these studies suggested that the Talking Typewriter was, as measured by some indices, an effective means of teaching reading; experimental groups showed gains significantly above those of control groups on some, but not all of the achievement measures which were used. This center felt that the typewriter did not provide an answer to all reading problems, but that it was one more instructional tool which was available. The center has used its evaluation results to more effectively allocate its resources by assigning students to the typewriter who are most likely to benefit from it (New York City Board of Education, 1968, 1969).

In 1970-71 an evaluation of the Talking Typewriter was conducted at the Minneapolis, Minnesota Center. Pre- and posttests were administered to 460 students whose average length of stay at the Basic Skill Centers was six months. Students made substantial gains in both reading comprehension and reading vocabulary. The average gain was between eight and nine months on both reading comprehension and vocabulary. About seven out of ten children in the program made gains of six months or more during this six month period. Almost half of the children made gains of one year (10 months in grade equivalent terms) or more during their six month period. The learning rate of students at the centers was better than expected for average children and substantially better than expected for those educationally disadvantaged children who were two to three years below grade level. These children probably were learning formerly at a rate of about three months over a six month period.

The effectiveness of the Talking Typewriter must also be weighed against its cost. The Edison Responsive Environment is such an expensive piece of equipment that people have looked to it as a panacea. Moore's films and reports of three-year-olds typing paragraphs from dictation (Moore, 1967) perhaps led people to expect such remarkable achievements from most students. It has been demonstrated that children can learn to read using the Talking Typewriter, even children who have not learned by other methods of instruction, but most students do not make spectacular gains beyond what they would

make in a regular classroom. Centers have learned that the typewriter is a useful tool to teach certain skills to certain types of students. Normal children can be taught to read using the typewriter and usually faster than by other methods, but most centers do not feel that the gains justify the additional cost. However, the typewriter has proven its usefulness with remedial readers, severely disadvantaged students, and mentally and physically handicapped children at a cost comparable to alternative methods. Also the typewriter can be used to teach things other than basic reading skills, but most centers have found it most effective in this area, particularly in the relationship of written symbols to speech.

DIFFUSION

Agency Participation

The Responsive Environment Corporation was formed in 1963 as a marketing organization for the Thomas A. Edison Laboratory. At first the company was closely held by a few individuals, but now Prentice Hall controls 25% of the shares while 50% are widely held and traded. The Laboratory, a separate organization, is no longer a subsidiary of McGraw Edison Company; half of its shares are controlled by McGraw Edison and half by Prentice Hall. REC began to market the Talking Typewriter in 1964. Since then, they have begun to market other products, including two "desktop" educational devices, the Talking Page and the Voice Mirror, which were both developed at the Laboratory.

Diffusion Strategy

Because the Talking Typewriter requires a substantial investment, the support of top school administrators is necessary. REC sales representatives generally attempt to identify districts who have a need for a product such as the Talking Typewriter and then contact administrators at these locations to explain the typewriter's capabilities.

Actual Diffusion Efforts

In the mid-1960's, people were becoming aware of the potential value of applying information processing technology in the field of education. Many electronics companies were expanding in this area, including giants such as

IBM, General Electric, Xerox, and RCA. In addition, the Federal Elementary and Secondary Education Act of 1965 provided funds for schools to spend on programs they could not afford previously. Educational technology was viewed as a potential means of solving many of our educational problems, including the low quality of education in urban schools.

The Talking Typewriter, which became available in 1964, was one of the early applications of the computer in an educational device and attracted widespread attention. Over a hundred full length articles, papers, and reports appeared on the typewriter, and it was mentioned in hundreds more. Visitation procedures were an important part of each center because so many people wanted to see it in operation. A film on the typewriter was widely distributed, and it was demonstrated at conventions. In response to requests for information, REC sent out kits of materials explaining the Talking Typewriter.

Many people were enthusastic about the Talking Typewriter, but the decision to purchase or lease the equipment was a major one and schools were reluctant to commit the funds. In the face of a limited market, REC reduced the size of its sales force and focused on providing more services to help clients plan programs and obtain the necessary funds.

REC marketed the Talking Typewriter without software for the first few years. Five to ten typewriters were being used for specific purposes by educators in small centers during this period. When REC began to sell the machine to schools in large quantities, they discovered, as did many of the other companies who went into the field of educational technology, that the hardware required appropriate software to be effective and that development of software required a major effort. REC then developed software in order to provide a more comprehensive system for users.

Product Characteristics and Other Factors Affecting Diffusion

Cost of the Talking Typewriter has been the major deterrent to widespread use. Many schools felt they could not afford it, although considerable efforts were made to locate funding. The change in economic conditions aggravated this situation, as the affluence of the schools in the late 1960's changed to tight budgets and cutbacks in services.

When the typewriter was first introduced, there was resistance on the part of some who feared that children would be taught completely by machines, but they soon viewed the typewriter more realistically and saw it as an aid to teachers and not something to replace them. Some had unrealistic expectations of the typewriter, but adjusted these expectations when they learned more about the machine and its capabilities and limitations. And there were some who, because of their educational philosophy, objected to how the machine was used and even to using a machine at all. Others were not interested in change or in the type of innovation which the machine made possible. If the typewriter created interest and support through its novel approach, it also attracted critics.

The Talking Typewriter does have limitations as a piece of equipment. It was one of the early applications of computer technology to education and, although it is much more sophisticated than equipment generally used in schools, more complex systems of computerized instruction are now available. The Talking Typewriter is not designed to use a computer in a way to enable branching based on student responses. The developers pointed out that while branching within individual lessons is not possible on the Talking Typewriter, branching is certainly possible from one lesson to the next. They feel this is an important point, since by using diagnostic tests and frequent progress checks, it is possible to obtain instruction which is as highly individualized as an elaborately branched program, but at a considerably cheaper cost. Also, the keyboard of the machine has established a format which makes it most appropriate for teaching reading skills. Although some people have suggested using it in other subject areas, this has not been done.

ADOPTION

Extent of Product Use

There were approximately 150 Talking Typewriters being used in 50 locations across the United States and in Israel in 1971. Most centers have one to three typewriters, but up to 20 are being used in one center. The number of students served at each center varies greatly according to their procedures, and no figures are available on the total number of students involved. The number of users jumped to about 50 in 1966; since then, the increase in the number of users has been rather modest. About one-third of the typewriters are used

with exceptional children, others are used with students who are encountering reading difficulties or are severely disadvantaged, and some are used primarily with adults. A few of the users have discontinued using the typewriter, but this was generally due to lack of funds rather than failure to obtain positive results.

Installation Procedures

REC has two full-time consultants who assist in planning the centers, train center personnel, suggest instructional procedures, and provide continuing services as required. The operation of each center varies according to their needs. Some centers are located in institutions and only have a few typewriters; some inner-city programs have up to 20 typewriters in one location, while other large projects have divided their typewriters among several centers to reduce transportation problems. The schedules of the centers also vary. Some are only open during the day, while others operate evenings, too. Some use the typewriter with several different target populations, while others just work with one. Some have students come to a center for a set period of time, while others have students work with the typewriter until a certain level of attainment is reached.

Special arrangements must be made for the centers. Each center requires an air-conditioned room for the typewriter booths as well as space and furniture for related classroom activities. At least one teacher is needed for each classroom, and one paraprofessional is needed for every two booths. Large centers also require a center director to handle administrative affairs. Operation of the Talking Typewriter is uncomplicated, and REC consultants provide the training which is needed. It takes just a few days to train attendants to operate the equipment and to encode programs for the typewriter. It also takes just a few days to train staff in the basic techniques of developing programs for the typewriter since they can be written in English; however, it takes a few weeks of practice to develop skill in programming. Consultants also train teachers in how to use the BRL Sullivan programs and related classroom activities. Service representatives from Thomas A. Edison Laboratory service the machines and repair them when necessary.

Center staff are encouraged to keep administrators and community groups informed of the center's activities, since their support is important for the

continuation of the program. Procedures are established for handling visitors so they can observe the operations of the center without disturbing the students. Some type of evaluation study is also recommended for each center to provide them with a basis for evaluating their program.

FUTURE OF THE PRODUCT

The Talking Typewriter represented a step in the field of educational technology. Evaluation results suggest it can be an effective teaching device. However, with the current financial crisis faced by schools across the country and the lack of funds for special programs, a large increase in users would not seem likely in the near future. However, REC is, in fact, anticipating a considerable increase in users, despite cutbacks in school funding. Negotiations are underway to establish a series of private reading clinics, such as the one now in operation in El Cajon, California. These centers will use the Talking Typewriter, Talking Page, Voice Mirror, as well as tutors, to provide highly individualized instruction. Centers will be supported through charging fees to clients. Despite the costs involved, REC has ascertained that this can be a profitable operation with efficient administration. Furthermore, it will meet a need which has been voiced by large numbers of individuals who have wanted to obtain such instruction for themselves and their children, but have not had access to Talking Typewriters in their local school systems.

An important point which can be drawn from this report is that private corporations have a very difficult time supporting the huge investment required to develop a well formulated and tested innovative educational product which deviates from a printed matter format. Such products are usually not profitable, even with substantial sales, and it may require some form of government support to provide an incentive for continued development in this field.

REC now has a division of "desktop technology" which is marketing the Talking Page and the Voice Mirror. The Talking Page, particularly, reflects the philosophy behind the Talking Typewriter. It is a small, current- or battery-operated audiovisual unit which is accompanied by a record that slips inside the machine and an illustrated booklet that is placed on top of the machine. The student listens to audio messages while following correlated visual messages in the booklet. What makes the product unique is that the student can control the message he hears by means of a simple lever. He can

repeat certain messages, review earlier material, or skip over material. Of course, this device is much simpler than the Talking Typewriter, and it has no control over student responses; however, it is similar in that the student can explore the material in different ways, progress at his own pace, and can control the information he receives. Materials for the Talking Page include programs in auditory and visual discrimination, phonics skills, language arts, and basic vocabulary and comprehension for elementary age children, and a low-literacy pre-vocational education program for teenagers and adults. The Talking Page is an example of a new way technology can be applied to educational problems and how families of products can be developed based on one approach.

CRITICAL DECISIONS

The following events are a good approximation of crucial decisions made in the fourteen-year history of the Talking Typewriter. For each decision point, the following types of information were considered: the decision that had to be made, the alternatives available, the alternative chosen, the forces leading up to choosing a particular alternative, and the consequences resulting from choosing an alternative.

Although an attempt has been made to present the critical decisions or turning points in chronological order, it must be clearly pointed out that these decisions were not usually made at one point in time, nor did they necessarily lead to the next decision presented in the sequence. Many of the critical decisions led to consequences that affected all subsequent decision making processes in some important way.

Decision 1: (Decision by Moore) To Develop a Methodology Using a Typewriter System

The first major decision in the history of the Edison Responsive Environment was the decision of Omar Khayyam Moore around 1958 to use an electric typewriter as a tool in his research on human problem solving. As he used the typewriter with young children, he developed his theoretical notions on the responsive autotelic environment and began to evolve a system for structuring such an environment centered around a typewriter.

Decision 2: To Automate Moore's Typewriter System

Moore's film and speeches had publicized his work and in 1959 Richard Kobler of the Thomas A. Edison Laboratory, then a subsidiary of McGraw Edison, contacted Moore. Moore and Kobler decided to collaborate on the automation of the system developed by Moore with a typewriter. Top management of the Laboratory and McGraw Edison Company agreed to provide company support for this venture into the field of educational technology, and the work began. Kobler directed the development of the automated typewriter and contributed the technology, while Moore provided advice on the methodological implications. Of course, many decisions were made on how the system should be automated and modified as it was being developed.

Decision 3: To Create REC to Market the Typewriter

The Thomas A. Edison Laboratory was a research company, and the decision was made in 1963 to form a separate corporation, the Responsive Environment Corporation, to market its products. Investors were willing to contribute to such an arrangement, and the company was incorporated. As a result, a sales force was developed and concentrated on promoting the automated version of the Talking Typewriter.

Decision 4: Decision to Develop a Software System

When REC began to sell the automated typewriter to schools in 1966, they found that the staffs in most schools did not have the time or resources to write separate typewriter programs for each student as Moore and other researchers who had used the equipment had done. REC wanted to develop a set of typewriter programs, the software, as quickly as possible, so they adapted an existing basic reading program, the Behavioral Research Laboratory's Sullivan program, for use with the typewriter. A set of 128 programs were developed by the fall of 1967; these were later revised and expanded into a comprehensive system of instruction for reading. If this decision had not been made, the Talking Typewriter would be in fewer schools today.

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APPENDIX A

LIST OF PRODUCTS AND DEVELOPERS

The following is a list of products for which Product Development Reports have been prepared.

Arithmetic Proficiency Training Program (APTP)
Developer: Science Research Associates, Inc.

The Creative Learning Group Drug Education Program
Developer: The Creative Learning Group
Cambridge, Massachusetts

The Cluster Concept Program
Developer: The University of Maryland,
Industrial Education Department

Developmental Economic Education Program (DEEP)
Developer: Joint Council on Economic Education

Distar Instructional System
Developer: Siegfried Engelmann & Associates

Facilitating Inquiry in the Classroom
Developer: Northwest Regional Educational Laboratory

First Year Communication Skills Program
Developer: Southwest Regional Laboratory for
Educational Research & Development

The Frostig Program for Perceptual-Motor Development
Developer: The Marianne Frostig Center of Educational Therapy

Hawaii English Program
Developer: The Hawaii State Department of Education
and The University of Hawaii

Holt Social Studies Curriculum
Developer: Carnegie Social Studies Curriculum Development Center,
Carnegie-Mellon University

Individually Prescribed Instruction--Mathematics (IPI--Math)
Developer: Learning Research and Development Center,
University of Pittsburgh

Intermediate Science Curriculum Study
Developer: The Florida State University,
Intermediate Science Curriculum Study Project

MATCH--Materials and Activities for Teachers and Children
Developer: The Children's Museum
Boston, Massachusetts

Program for Learning in Accordance With Needs (PLAN)
Developer: American Institutes for Research and
Westinghouse Learning Corporation

Science--A Process Approach
Developer: American Association for the Advancement of Science

Science Curriculum Improvement Study
Developer: Science Curriculum Improvement Study Project
University of California, Berkeley

Sesame Street
Developer: Children's Television Workshop

The Sullivan Reading Program
Developer: Sullivan Associates
Menlo Park, California

The Taba Social Studies Curriculum
Developer: The Taba Social Studies Curriculum Project
San Francisco State College

The Talking Typewriter or
The Edison Responsive Environment Learning System
Developer: Thomas A. Edison Laboratory,
a Subsidiary of McGraw Edison Company

Variable Modular Scheduling Via Computer
Developer: Stanford University and
Educational Coordinates, Inc.